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Cheng et al.

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(54) **ELECTRONIC APPARATUS**

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349/56–60; 312/223.1–223.3; 348/787,
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See application file for complete search history.

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(57)

ABSTRACT

An electronic apparatus includes the following elements. A housing has at least an opening and an accommodating space. A first circuit board is disposed in the accommodating space. A battery module disposed in the accommodating space is stacked over the first circuit board. A display module disposed in the accommodating space is stacked over the battery module. The display module is visible through the opening. A second circuit board is disposed in the accommodating space and beside the battery module. At least a part of the second circuit board is not disposed below the display module. A first speaker is disposed in the accommodating space and below the part of the second circuit board. The first speaker has a top side with a first sound hole aligned to a slot of the part of the second circuit board.

20 Claims, 8 Drawing Sheets

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Related U.S. Application Data

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filed on Sep. 28, 2012, now Pat. No. 9,137,918, and a
continuation-in-part of application No. 14/182,301,
filed on Feb. 18, 2014, now Pat. No. 9,253,555.

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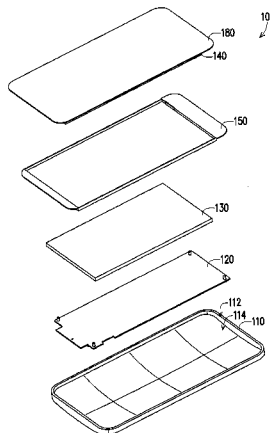
G06F 1/1626 (2013.01); **H04M 1/0202**

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H05K 5/00–5/069; H05K 7/00–7/186



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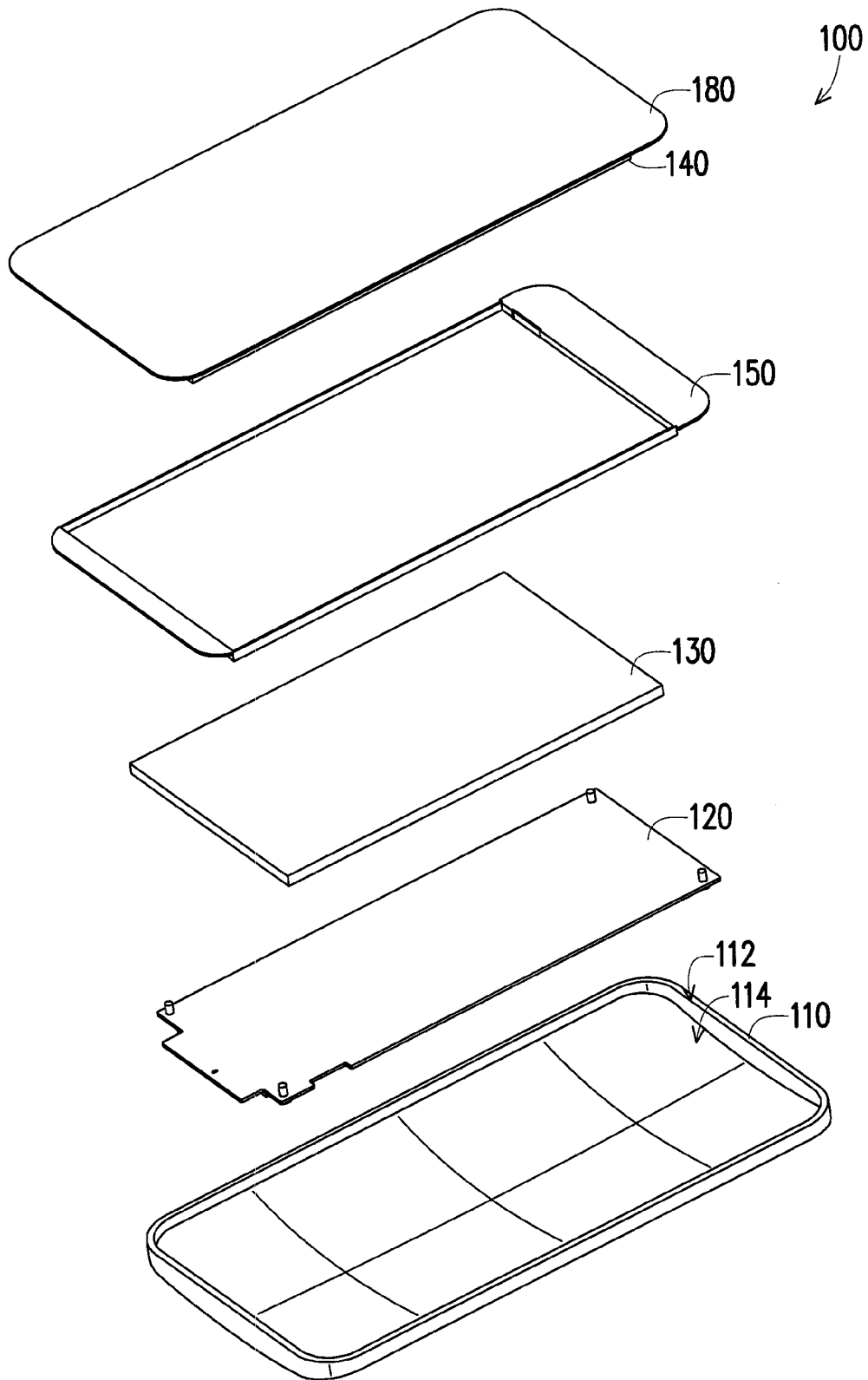


FIG. 1

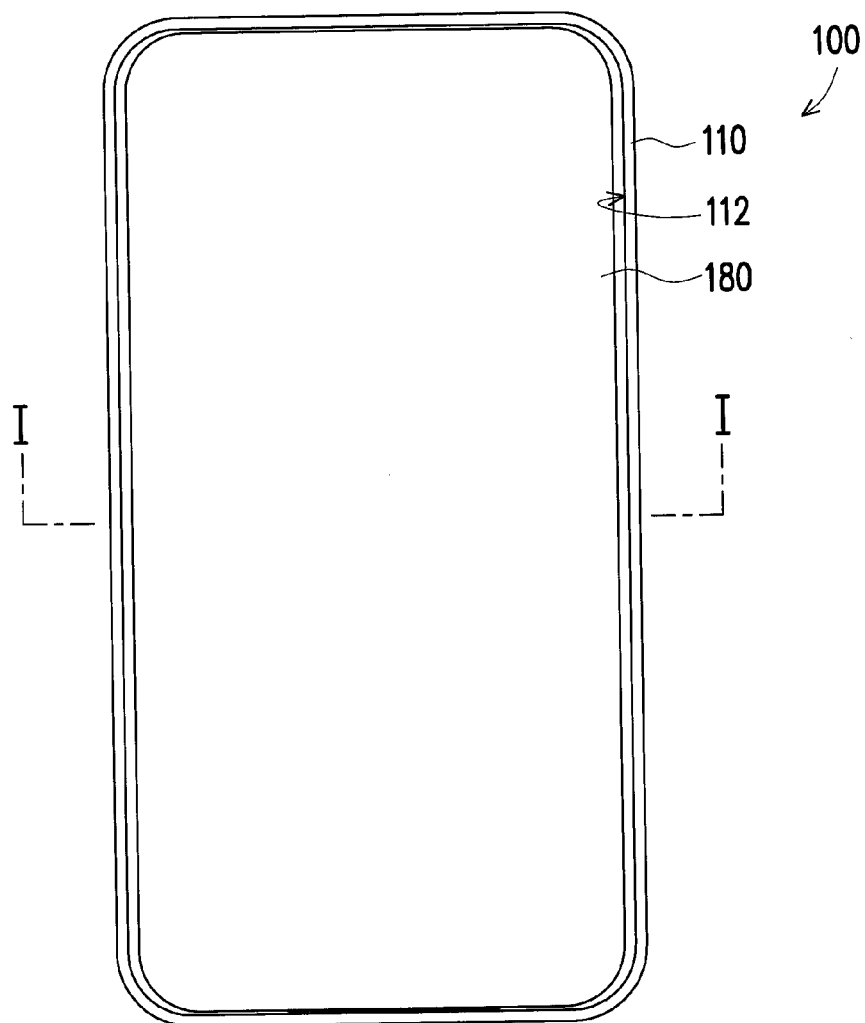


FIG. 2

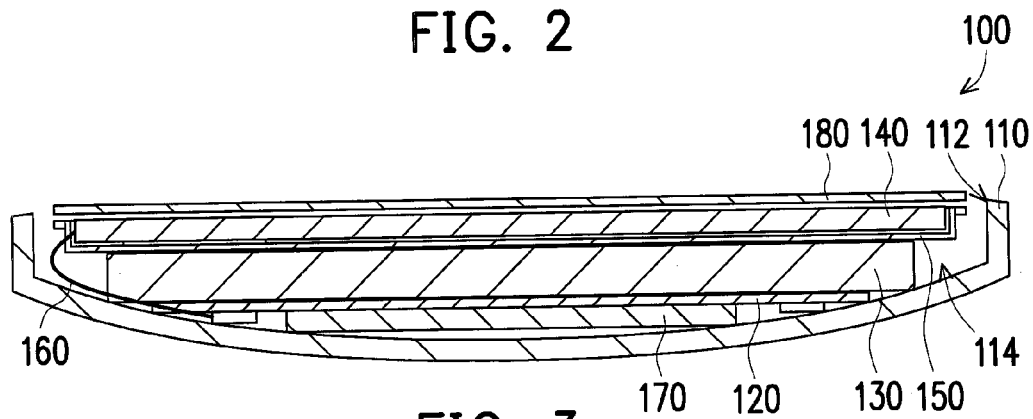


FIG. 3

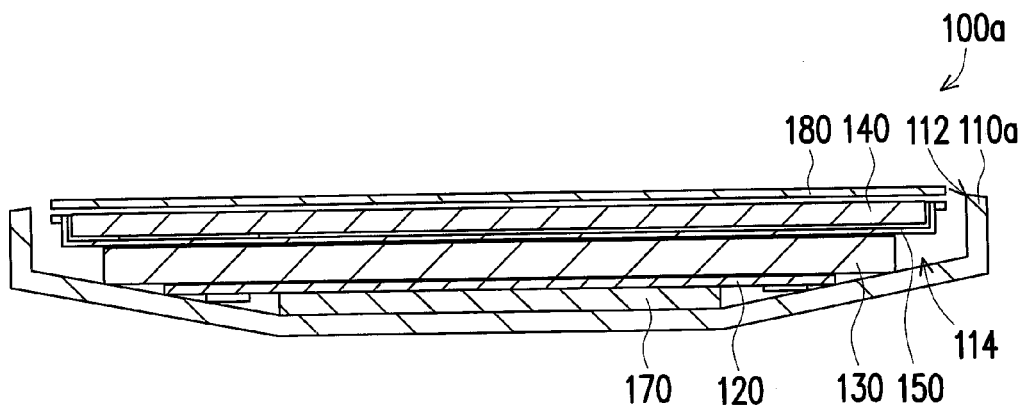


FIG. 4

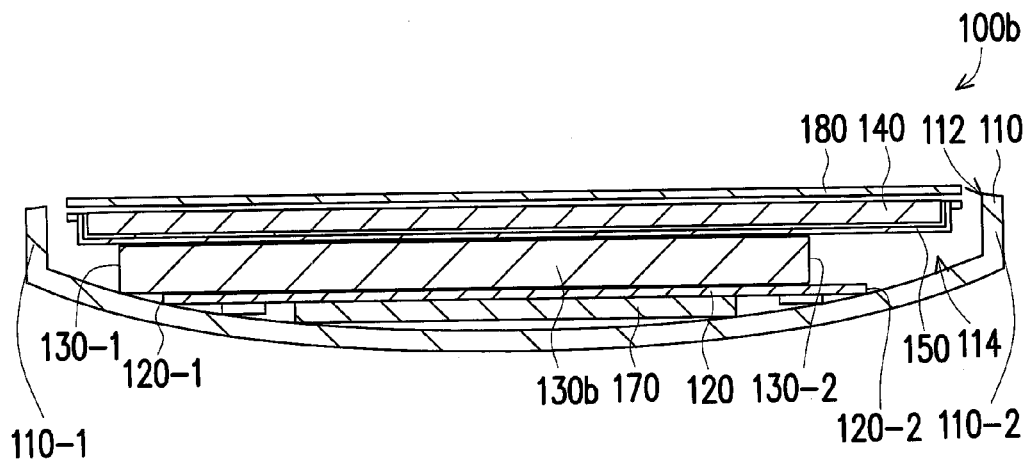


FIG. 5

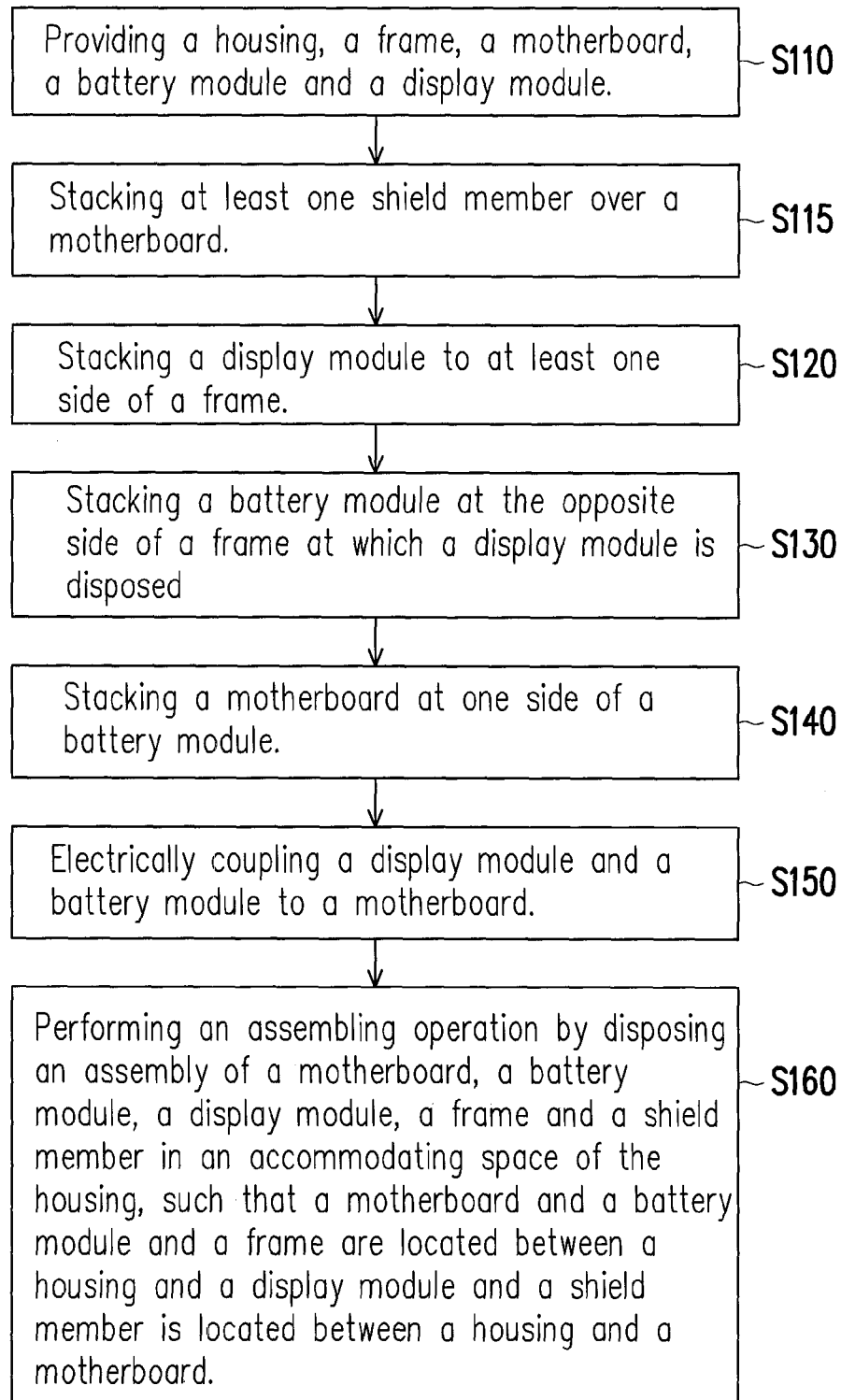


FIG. 6

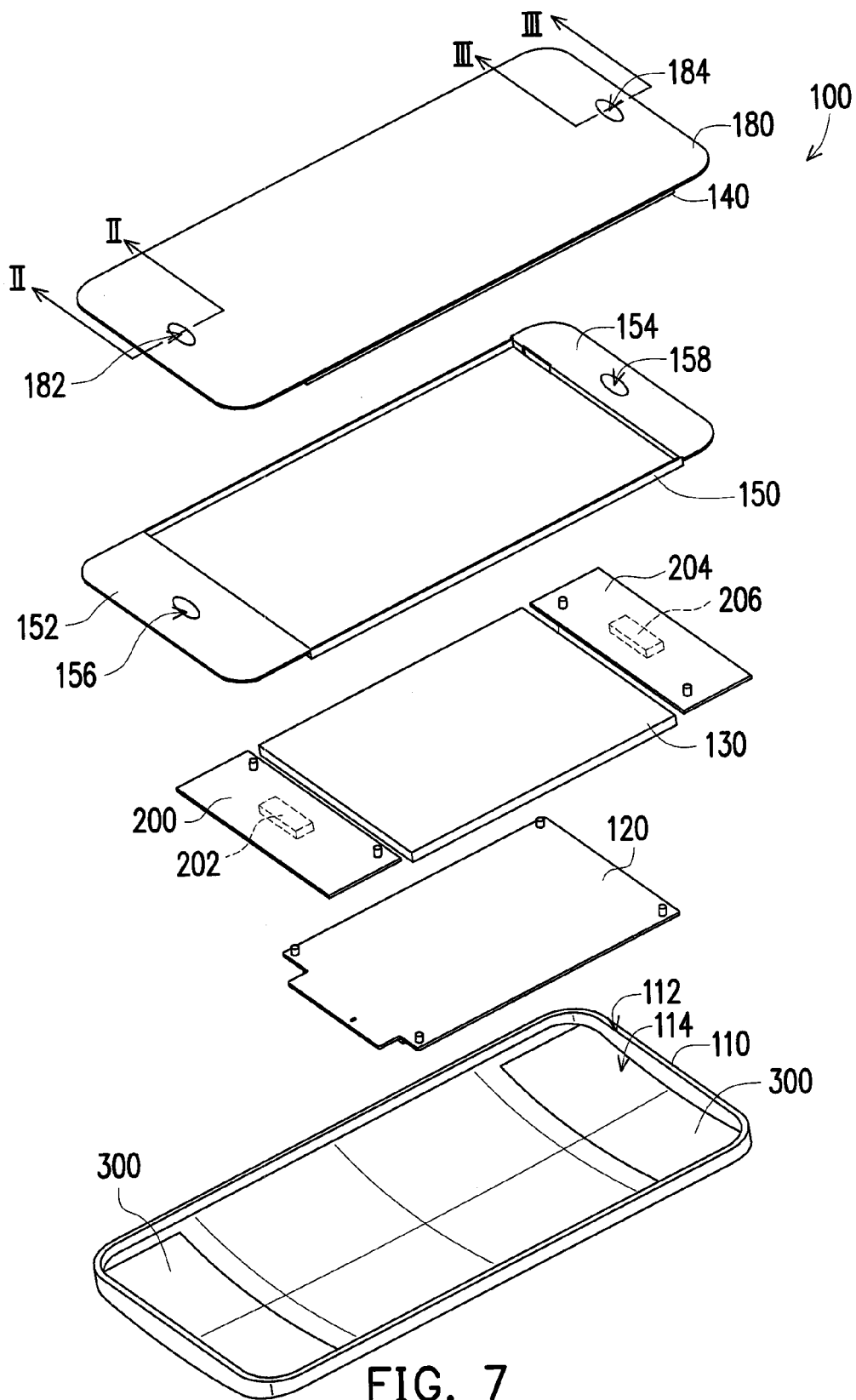


FIG. 7

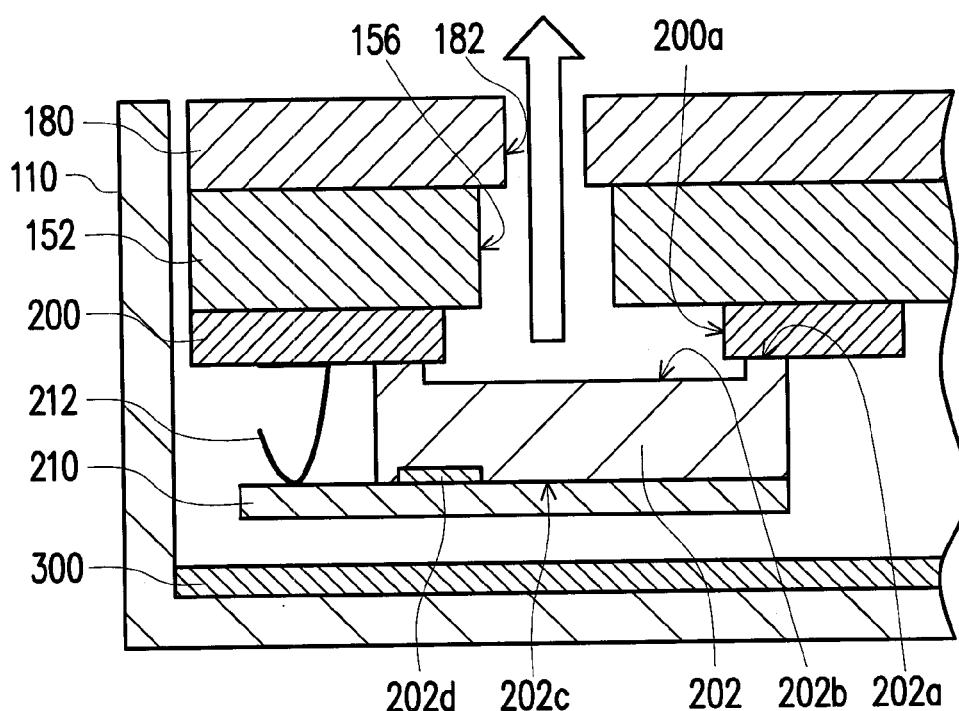


FIG. 8

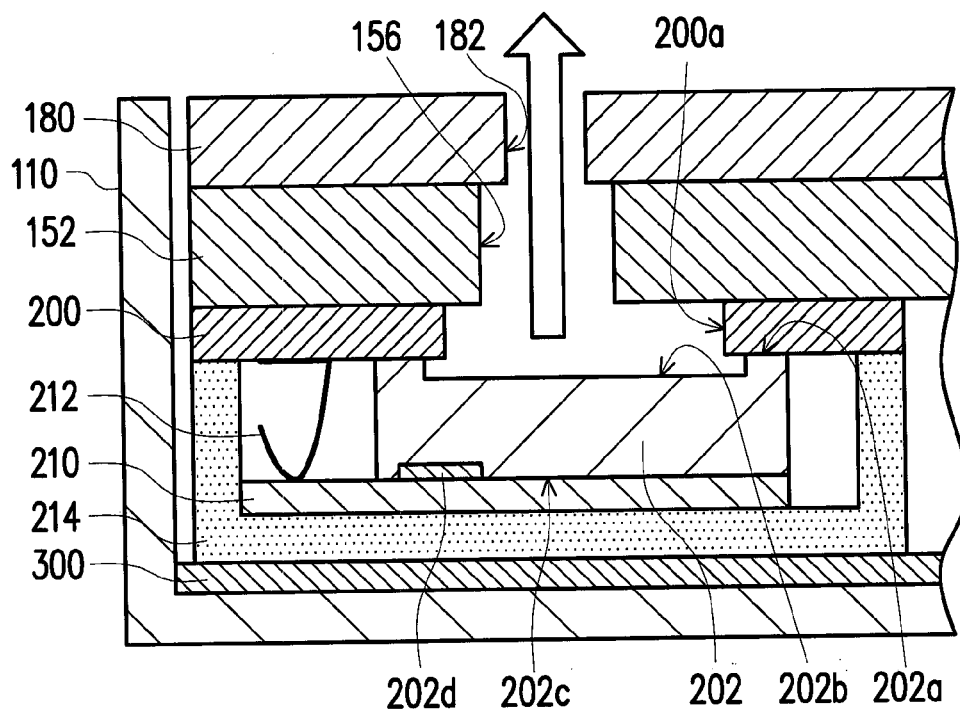


FIG. 9

FIG. 11

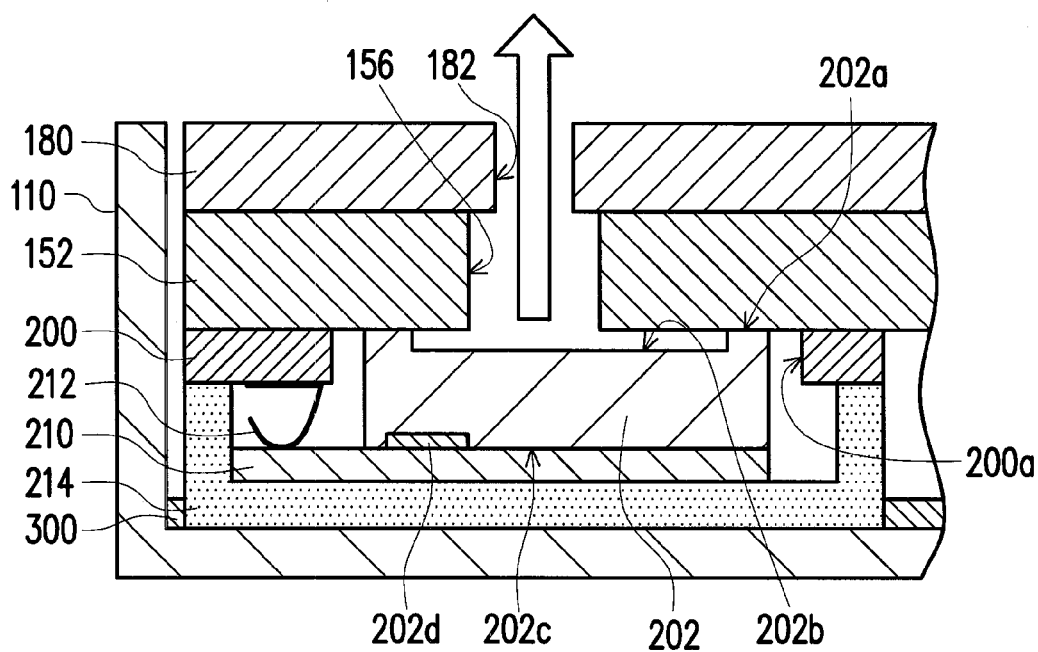


FIG. 12

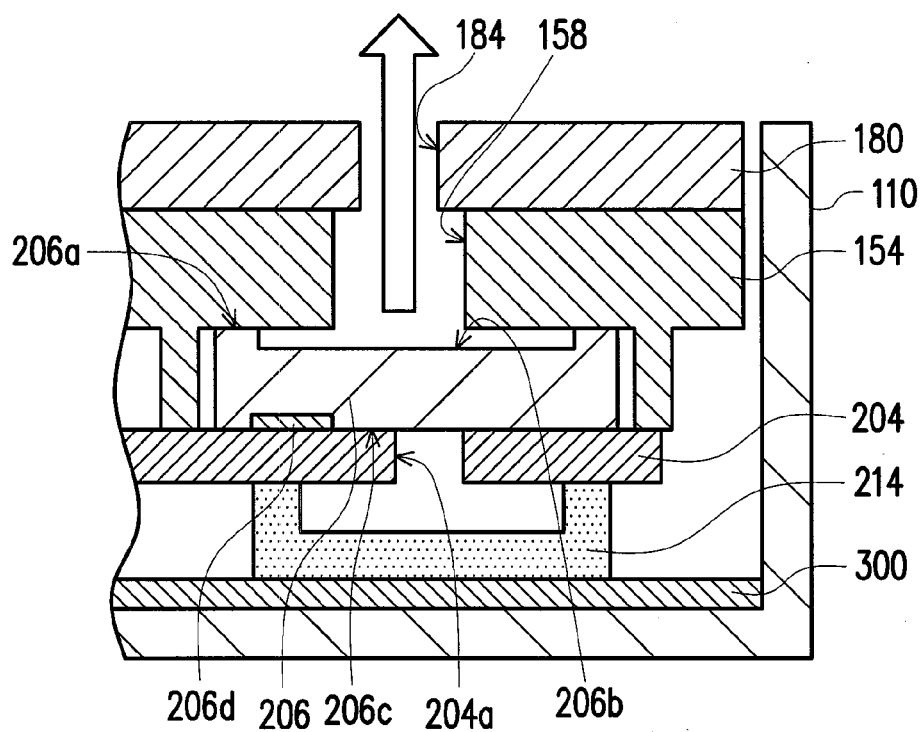


FIG. 13

ELECTRONIC APPARATUS**CROSS-REFERENCE TO RELATED APPLICATION**

This application is a continuation-in-part application of and claims the priority benefit of a prior application Ser. No. 13/629,625, filed on Sep. 28, 2012, now pending. This application is also a continuation-in-part application of and claims the priority benefit of a prior application Ser. No. 14/182,301, filed on Feb. 18, 2014, now pending. The entirety of each of the above-mentioned patent applications is hereby incorporated by reference herein and made a part of this specification.

FIELD OF THE INVENTION

The application relates to an electronic apparatus.

DESCRIPTION OF RELATED ART

In recent years, as the technology advances, handheld devices such as mobile phones, tablet computers are more commonly used and are developed to be more convenient, multi-functional and exquisite. More and more choices like the aforementioned are provided for consumers to choose from. Users have higher demands toward the handheld devices day by day. As the time prolongs for users to hold handheld devices by hands, the feeling in holding handheld devices are getting more important.

In order to enhance the feeling in holding handheld devices, a housing surface of handheld electronic devices are often designed to have a curved surface to conform designs of ergonomics. However, according to the current stacking method of interior space of handheld devices, a battery is closer to a housing of a handheld device than a motherboard, and therefore such handheld device cannot present a smooth arc shape due to the battery disposition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of an electronic apparatus according to an embodiment of the application.

FIG. 2 is a front view of an assembled electronic apparatus of FIG. 1.

FIG. 3 is an enlarged cross-sectional view of the electronic apparatus along the line I-I of FIG. 2.

FIG. 4 is an enlarged cross-sectional view of an electronic apparatus according to another embodiment of the application.

FIG. 5 is an enlarged cross-sectional view of an electronic apparatus according to yet another embodiment of the application.

FIG. 6 is a flow chart of a method for assembling an electronic apparatus according to an embodiment of the application.

FIG. 7 is an exploded view of an electronic apparatus according to another embodiment of the application.

FIG. 8-12 are enlarged cross-sectional views of the electronic apparatus, cutting at line II-II in FIG. 7, according to other embodiments of the application.

FIG. 13 is an enlarged cross-sectional view of the electronic apparatus, cutting at line III-III in FIG. 7, according to another embodiment of the application.

SUMMARY OF THE INVENTION

The application is directed to an electronic apparatus with a smooth and curved surface of a housing.

The application provides an electronic apparatus including a housing, a first circuit board, at least one second circuit board, a battery module and a display module. The housing has at least an opening and an accommodating space. The first circuit board is disposed in the accommodating space. The battery module is disposed in the accommodating space and stacked over the first circuit board. The display module is disposed in the accommodating space and stacked over the battery module. At least one edge of the battery module in a width direction of the housing is closer to a corresponding side of the housing than a corresponding edge of the first circuit board in a width direction of the first circuit board. At least one second circuit board is disposed in the accommodating space and stacked over the display module, beside the battery module, wherein the at least one second circuit board has a speaker.

The application provides an electronic apparatus includes the following elements. An electronic apparatus includes the following elements. A housing has at least an opening and an accommodating space. A first circuit board is disposed in the accommodating space. A battery module is disposed in the accommodating space is stacked over the first circuit board. A display module is disposed in the accommodating space is stacked over the battery module. The display module is visible through the opening. A second circuit board is disposed in the accommodating space and beside the battery module. A part of the second circuit board is not disposed below the display module. A first speaker is disposed in the accommodating space and below the part of the second circuit board. The first speaker has a top side with a first sound hole aligned to a slot of the part of the second circuit board.

In light of the foregoing, in the application, an appearance of a housing of an electronic apparatus can be presented as a smooth and curved surface to effectively utilize a space inside the housing and increase a capacity of a battery module.

In order to make the aforementioned features and advantages of the application more comprehensible, embodiments accompanying figures are described in details below.

DESCRIPTION OF EMBODIMENTS

FIG. 1 is an exploded view of an electronic apparatus according to an embodiment of the application. FIG. 2 is a front view of an assembled electronic apparatus of FIG. 1. FIG. 3 is an enlarged cross-sectional view of the electronic apparatus along the line I-I of FIG. 2. Referring to FIG. 1 to FIG. 3. In the present embodiment, an electronic apparatus 100 includes a housing 110, a motherboard 120, a battery module 130 and a display module 140.

The housing 110 has at least an opening 112 and an accommodating space 114. The motherboard 120 is disposed in the accommodating space 114, wherein the motherboard 120 includes a rigid circuit board and a plurality of electronic components mounted on the rigid circuit board. The battery module 130 is disposed in the accommodating space 114 and stacked over the motherboard 120, wherein the motherboard 120 is located between the housing 110 and the battery module 130. The display module 140 is disposed in the accommodating space 114 and stacked over the battery module 130, wherein the battery module 130 is located between the motherboard 120 and the display module 140. The display module 140 can have either a plug-in or build-in touch module.

In the present embodiment, a width of the motherboard 120 is smaller than a width of the battery module 130, and the width of the battery module 130 is smaller than a width of the display module 140. Accordingly, an appearance of the housing 110 can be presented as a smooth arc shape. Meanwhile,

the width of the battery module **130** is widened when the battery module **130** is moved to a location between the motherboard **120** and the display module **140**. As a result, with the same length and thickness, the width of the battery module **130** is widened to increase a capacity of the battery module **130**.

It should be noted that any width of any member disclosed in the application is a width in a horizontal direction of the member illustrated in FIG. 2 or FIG. 3.

Referring to FIG. 3 again. In the present embodiment, the housing **110** can extend along a curved surface, and edges of the motherboard **120** and edges of the battery module **130** lean against the housing **110**. In another embodiment illustrating an electronic apparatus **100a**, as shown in FIG. 4, a housing **110a** can extend along an inclined plane.

Referring to FIG. 3 again. In the present embodiment, the electronic apparatus **100** further includes a frame **150** wherein the frame **150** is disposed between the battery module **130** and the display module **140** to secure a relative position between the battery module **130** and the display module **140**.

Referring to FIG. 3 again. In the present embodiment, the electronic apparatus **100** further includes a flexible printed circuit board **160** that connects the motherboard **120** and the display module **140**. Specifically, the flexible printed circuit board **160** bypasses the battery module **130** and connects the motherboard **120** and the display module **140**.

Referring to FIG. 3 again. In the present embodiment, the electronic apparatus **100** further includes a shield member **170** disposed in the accommodating space **114**, wherein the shield member **170** is located between a bottom of the housing **110** and the motherboard **120**, and a width of the shield member **170** is smaller than the width of the motherboard **120**.

Referring to FIG. 1 and FIG. 3 again. In the present embodiment, the electronic apparatus **100** further includes a cover plate **180** disposed at the opening **112** of the housing **110**, such that the display module **140** is located between the battery module **130** and the cover plate **180**. The width of the display module **140** is smaller than a width of the cover plate **180**.

FIG. 5 is an enlarged cross-sectional view of an electronic apparatus according to yet another embodiment of the application. Referring to FIG. 5. According to an electronic apparatus **100b** of the present embodiment, one edge **130-1** of a battery module **130b** in a width direction of the battery module **130b** is closer to a corresponding side **110-1** of the housing **110** than a corresponding edge **120-1** of the motherboard **120** in a width direction of the motherboard **120**. In addition, one edge **130-2** of the battery module **130b** in a width direction of the battery module **130b** is not closer to a corresponding side **110-2** of the housing **110** than a corresponding edge **120-2** of the motherboard **120** in a width direction of the motherboard **120**. As a result, according to embodiments of FIG. 3 and FIG. 5, at least one edge of the battery module in a width direction of the battery module is closer to a corresponding side of the housing than a corresponding edge of the motherboard in a width direction of the motherboard.

FIG. 6 is a flow chart of a method for assembling an electronic apparatus according to an embodiment of the application. Referring to FIG. 1 and FIG. 6. In Step S110, the housing **110**, the motherboard **120**, the battery module **130**, the display module **140** and the frame **150** are provided, wherein the housing **110** has the opening **112** and the accommodating space **114**, the width of the motherboard **120** is smaller than the width of the battery module **130**, and the width of battery module **130** is smaller than the width of the

display module **140**. In Step S120, the display module **140** is stacked at one side of the frame **150**.

In Step S130, the battery module **130** is stacked at the opposite side of the frame **150** at which the display module **140** is disposed. In Step S140, the motherboard **120** is stacked at one side of the battery module **130**. In Step S150, the display module **140** and the battery module **130** are electrically coupled to the motherboard **120**. In Step S160, an assembling operation is performed, wherein an assembly of the motherboard **120**, the battery module **130**, the display module **140** and the frame **150** are disposed in the accommodating space **114** of the housing **110**.

Referring to FIG. 3 and FIG. 6. The present embodiment further includes Step S115. In Step S115, before performing the assembling operation (Step S160), the shield member **170** is stacked over the motherboard **120**, wherein the width of the shield member **170** is smaller than the width of the motherboard **120**. After the assembling operation (Step S160) is performed, the shield member **170** is also disposed in the accommodating space **114** and located between the housing **110** and the motherboard **120**.

Referring to FIG. 3 and FIG. 6. In the present embodiment, a step of electrically coupling the display module **140** to the motherboard **120** in Step S150 includes having the flexible printed circuit board **160** bypassing the battery module **130** and connecting the display module **140** and the motherboard **120**.

Furthermore, another circuit board carrying speaker can be assembled together but still keeping the smooth curving shape of the housing. For easy description, the motherboard can also be referred as a first circuit board, and the circuit board carrying speaker can be referred as a second circuit board.

FIG. 7 is an exploded view of an electronic apparatus according to another embodiment of the application. In FIG. 7, the assembly structure is similar to the structure shown in FIG. 1. However, at least one circuit board is further included. In the embodiment, a second circuit board **200** and a third circuit board **204** are provided as an example. The second circuit board **200** and the third circuit board **204** respectively carry a first speaker **202** and a second speaker **206** and, like the battery **130**, are disposed below the display module **140**, in which the second circuit board **200** and the third circuit board **204** are actually disposed on the frame **150** as an example. The display module **140** is visible through the opening **112**. The first speaker **202** is disposed in the accommodating space **114** and disposed below the second circuit board **200**. The second speaker **206** is also disposed in the accommodating space **114** and disposed below the third circuit board **204**.

The frame **150** is stacked over the battery module **130** and disposed below the display module **140** to secure a relative position between the battery module **130** and the display module **140**. The frame **150** has at least one protruding end plate, such as two protruding end plates **152**, **154**, corresponding to the second circuit board **200** and the third circuit board **204**. As a result, for example, the stereo sound effect can be achieved by the first speaker **202** and the second speaker **206**. Each of the protruding end plates **152**, **154** of the frame **150** has an aperture **156**, **158**, which are respectively aligned to the first speaker **202** and the second speaker **206**. Further, the cover plate **180** also has at least one acoustic port, such as two acoustic ports **182**, **184**, which are also respectively aligned to the first speaker **202** and the second speaker **206**. End sides of the display module **140** extend to the acoustic ports **182**, **184** respectively, but does not covering the acoustic ports **182**, **184**. Further, each of the second circuit board **200** and the

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third circuit board **204** may also have a proper opening without stopping the sound from the speaker. As a result, the sound from the speaker can be transported to the external environment from the cover plate **180**.

Basically, the second circuit board **200** and the third circuit board **204** are not higher than the battery module **130**, so the second circuit board **200** and the third circuit board **204** can be well disposed in the accommodating space **114** to fit the shape of the housing **110**. The second circuit board **200** and the third circuit board **204** are beside the battery module **130** on the frame **150** as a general example.

As to the design of the structure to adapt the speaker, it can be categorized into two side types: bottom (bot) side type and top side type, depending on the sound-exiting side of the speaker is in front of the circuit board as the top side type or the speaker is behind the circuit board as the bottom side type.

FIG. 8-12 are enlarged cross-sectional views of the electronic apparatus, cutting at line II-II in FIG. 7, according to other embodiments of the application.

In FIG. 8, the speaker is one in design of bottom side type, as an example. The sound from the first speaker **202** is indicated by thick arrow. In this structure, the second circuit board **200** has a slot **200a**, the protruding end plate **152** also has the aperture **156** indicated in FIG. 7, and the cover plate **180** also has the acoustic port **182**, so that the sound can be transported forwardly out from the cover plate **180**. The first speaker **202** has a top side **202a** with a first sound hole **202b** and a bottom side **202c** with a first contact point **202d**, and the first contact point **202d** is electrically connected to the second circuit board **200**. Here, a first conductive part **210** may also be needed to electrically connect the first speaker **202**, so that the first speaker **202** can be electrically connected to the second circuit board **200** via the first conductive part **210** and a second conductive part **212**. The second conductive part **212** contacts the first conductive part **210** and the second circuit board **200** separately. The first conductive part **210** may be a flexible printed circuit board, and the second conductive part **212** may be a conductive elastic pad.

In FIG. 8, the second circuit board **200**, the first speaker **202** and the first conductive part **210** may be rather close to the housing **110**, which usually has an antenna **300**. Since the second circuit board **200** may affect the antenna **300**, served by the housing **110**, the second circuit board **200** should be stacked over the first speaker **202** in order to increase the distance between the second circuit board **200** and the antenna **300**. In the embodiment, the second circuit board **200** need not be too close to the housing **110** with the antenna **300**, and the first conductive part **210** is distant from the housing **110**.

Further in FIG. 9, it is also another design of bottom side type. However, an additional cap structure **214** can cover the first speaker **202**. The cap structure **214** can also prevent the influence on the antenna **300**.

In FIG. 10, based on the structure of FIG. 9, the sound exiting side of the first speaker **202** may also be disposed below the protruding end plate **152** of the frame **150** via the slot **200a** of the second circuit board **200**, and the slot **200a** of the second circuit board **200** may be sufficiently large to adapt the first speaker **202**.

Further in FIG. 11, it is also another design of bottom side type. However, an additional cap structure **214** can cover the first speaker **202**.

Further in FIG. 12, the housing **110** has a cap structure **214** corresponding to the first speaker **202** and covering the first speaker **202**. In other words, the cap structure **214** is integrally formed with the housing **110** to be an integrative unit.

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Further in FIG. 13, it is a design of top side type. As can be seen, the second speaker **206** is stacked on the third circuit board **204** with directly electrical contact. Specifically, the second speaker **206** has a top side **206a** with a second sound hole **206b** and a bottom side **206c** with a second contact point **206d**, and the second contact point **206d** is electrical connected to the third circuit board **204**. An additional cap structure **214** served as a sound box of the second speaker **206** is disposed below the third circuit board **204** and communicates with the second speaker **206** via a slot **204a** of the third circuit board **204**. In this structure, the protruding end plate **154** also has the aperture **158** indicated in FIG. 7, and the cover plate **180** also has the acoustic port **184**, so that the sound can be transported forwardly out from the cover plate **180**. In the present embodiment, since the antenna **300** is not seriously influenced by the third circuit board, the second speaker **206** may be stacked over the third circuit board **204**.

In light of the foregoing, the application presents an appearance of an electronic apparatus as a smooth arc shape, and a stacking method inside a space of the electronic apparatus allows interior components to be disposed in a housing with a design of a curved surface or an inclined plane. Accordingly, the application can effectively utilize an interior space of a housing to increase a capacity of a battery module.

Although the application has been described with reference to the above embodiments, it is not intended to limit the application. It will be apparent to people of ordinary skill in the art that modifications and variations to the described embodiments may be made without departing from the spirit and scope of the application. Accordingly, the scope of the application will be defined by the attached claims not by the above detailed descriptions.

What is claimed is:

1. An electronic apparatus, comprising:

- a housing having at least an opening and an accommodating space;
- a first circuit board disposed in the accommodating space;
- a battery module disposed in the accommodating space and stacked over the first circuit board;
- a display module disposed in the accommodating space and stacked over the battery module, wherein the display module is visible through the opening;
- a second circuit board disposed in the accommodating space and beside the battery module, wherein a part of the second circuit board is not disposed below the display module; and
- a first speaker disposed in the accommodating space and disposed below the part of the second circuit board, wherein the first speaker has a top side with a first sound hole aligned to a slot of the part of the second circuit board.

2. The electronic apparatus of claim 1, wherein the first speaker has a bottom side with a first contact point, and the first contact point is electrically connected to the second circuit board.

3. The electronic apparatus of claim 1, wherein the width of the first circuit board is smaller than the width of the battery module and the width of the battery module is smaller than a width of the display module.

4. The electronic apparatus of claim 1, wherein an edge of the battery module in a width direction of the battery module is closer to a corresponding one of two sides of the housing opposite to each other than a corresponding edge of the first circuit board in a width direction of the first circuit board.

5. The electronic apparatus of claim 1, further comprising: a frame stacked over the battery module and disposed below the display module to secure a relative position

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between the battery module and the display module, wherein the frame has a protruding end plate, and the protruding end plate has an aperture aligned to the first speaker of the second circuit board.

6. The electronic apparatus of claim 5, wherein the second circuit board is disposed below the protruding end plate of the frame, and the first speaker is either fixed to the protruding end plate and located in a slot of the part of the second circuit board, or fixed to the second circuit board and aligned to an aperture of the protruding end plate.

7. The electronic apparatus of claim 6, further comprising: a first conductive part disposed on the bottom side of the first speaker and attached to the first contact point; and a second conductive part contacting the first conductive part and the second circuit board separately.

8. The electronic apparatus of claim 7, wherein the first conductive part is a flexible printed circuit board, and the second conductive part is a conductive elastic pad.

9. The electronic apparatus of claim 1, further comprising: a cover plate disposed at the opening, wherein the display module is located between the battery module and the cover plate, wherein the cover plate has an acoustic port aligned to the first speaker.

10. The electronic apparatus of claim 9, wherein an end side of the display module extends to the acoustic port, but does not covers the acoustic port.

11. The electronic apparatus of claim 1, further comprising:

a cap structure covering the second circuit board and the first speaker, and served as a sound box of the first speaker.

12. The electronic apparatus of claim 1, wherein the housing has a cap structure corresponding to the first speaker and covering the first speaker, and the cap structure is integrally formed with the housing as an integrative unit.

13. The electronic apparatus of claim 1, further comprising:

a third circuit board disposed in the accommodating space, beside the battery module and opposite to the second circuit board with respect to the battery module, wherein a part of the third circuit board is exposed from the display module; and

a second speaker disposed in the accommodating space and disposed below the part of the third circuit board,

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wherein the second speaker has a top side with a second sound hole aligned to a slot of the part of the third circuit board.

14. The electronic apparatus of claim 13, wherein the second speaker has a bottom side with a second contact point, and the second contact point is electrically connected to the third circuit board.

15. The electronic apparatus of claim 13, further comprising:

a frame stacked over the battery module and disposed below the display module to secure a relative position between the battery module and the display module, wherein the frame has a protruding end plate, and the protruding end plate has an aperture aligned to the second speaker.

16. The electronic apparatus of claim 15, wherein the third circuit board is disposed below the protruding end plate of the frame, and the second speaker is disposed between the protruding end plate and the third circuit board and communicated with an aperture of the protruding end plate.

17. The electronic apparatus of claim 13, further comprising:

a cover plate disposed at the opening, wherein the display module is located between the battery module and the cover plate, wherein the cover plate has an acoustic port aligned to the second speaker.

18. The electronic apparatus of claim 13, further comprising:

a cap structure disposed below the third circuit board, communicating with the second speaker via a slot of the third circuit board, and served as a sound box of the second speaker.

19. The electronic apparatus of claim 13, further comprising:

a second antenna disposed inside the housing, wherein at least a part of the second antenna is orthogonally overlapped with the third circuit board.

20. The electronic apparatus of claim 1, further comprising:

a first antenna disposed inside the housing, wherein at least a part of the first antenna is orthogonally overlapped with the second circuit board.

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